and habits of *Limulus* throw much light on the probable anatomy and habits of Trilobites. The author infers that the eyes had a similar structure, that the circulation and the nervous system were alike, and that probably the genital organs were very similar in the two groups. He thence suggests that the eggs of the Trilobite were probably laid in the sand or mud and impregnated by the sperm-cells of the male floating freely in the water. The Trilobites probably lived by burrowing in the mud and sand, digging in the shallow palæozoic waters after worms and stationary soft-bodied Invertebrates.—*The American Chemist*, Nov. 1870.

On the Stipules of Magnolia *and* Liriodendron.

By Thomas Meehan.

An examination of the stipules of *Magnolia* affords some highly interesting facts, most or perhaps all of which are known to leading botanists, but which do not appear to be as generally known as they deserve to be; and these facts may have a more intimate bearing on many of the questions connected with the laws of development than is suspected.

In most species of *Magnolia* a scar peculiar to the genus exists on the petiole. This scar is elevated somewhat above the surrounding tissue, as if the matter forming it had been laid on the surface after the rest of the petiole had been formed. The green is not of the same tint as in the rest of the petiole, but it is always of the same tint as that of the leaf-blade. In *Magnolia macrophylla* the petiole and under surface of the leaf are grey; the leaf-blade is pale green on the upper surface. The surface of the scar is pale green, corresponding to the surface of the leaf-blade. The whole appearance of the scar is such as if a portion of a leaf-blade had been grafted by its under surface on the petiole.

On the upper part of the scar next the leaf-blade are two small articulation points, where the membranaceous stipules finally parted from the leaf. Examining a leaf before these stipules have fallen, the main veins forming the skeleton of the stipules are found connecting with these articuli, and, spreading out, diverge downward toward the base of the leaf. In separating at maturity from the petiole, they part first from the base, and last from their place of articulation. Their weakest hold is the point furthest away from what thus appears to be their source at the apex of the scar.

Magnolia Frazeri elongates its petiole beyond the stipule several inches generally. The leaf-blade then exhibits the auricle so well known in this species. The structure of this auricle is similar to the stipules in *M. macrophylla* or *M. tripetala*. The veins start out in nearly as close a fascicle as in these stipules, and they diverge and curve downwards just as these stipules do. Above these strong veins of the auricle are very weak veins, necessitating a very narrow blade portion there, until another set of strong veins push out and make the main part of the lamina.

If we press these auricles back against the petiole, and imagine a

union with it, then a separation from the main leaf-blade, and a union of the edges of the separated auricle, both above and below, we have a sheathed stipule exactly as we find them, and we see how easily *Magnolia Frazeri* might be a pinnate leaf of five leaflets on the supposition that the stipular portions really have taken the course we suppose these auricles might take.

I suppose no one of experience in living plants doubts the possibility of the adhesion of some parts and the separation of others, so as to make new parts or organs. If such is desired, I would refer to the *adhesion* of the carpellary leaves by their backs in the capsules of *Staphylea trifolia*, and, for *separation*, to the pinnate leaf often formed out of an entire blade in *Fraxinus excelsior*, *heterophylla*, and many other plants with entire leaves which often have pinnate ones amongst them.

It is scarcely possible, with these facts before us, to avoid the suspicion that the stipules of *Magnolia* are not formed like the stipules of most plants, which are perhaps leaf-portions which have never been well developed, but rather are the tolerably well-developed side pinnules of a trifoliate or deeply auricled leaf, which in an early stage had adnated with the petiole and by their edges, and thus formed the stipular sheath we see. The suppositional case I have drawn from the auricles of *M. Frazeri* is still better illustrated by leaves of some Ranunculaceous plants. For instance, *Anemone pennsylvanica*. Lay the lower lobes flat against the petiole, imagine the adnation by their backs, and cohesion of the edges, and we have the idea clearly.

It is difficult to conceive that these stipular sheaths could have been formed, in harmony with all the appearances we have detailed, in any other way; but ideas and possibilities are not as good as direct facts. These are furnished in good part in other ways.

In the East-Indian species *M. fuscata* the flowers are axillary, not terminal as in most other species. Three of the leaf-axils on the growth of last year produce flowers. The lowest flower is the weakest, the upper the strongest. The bracts which infold the flower-buds are of course transformed leaves; and here, in these weak flowers, where the tendency of the vital course is almost as near to foliar organs as to floral parts, we find these leafy-looking bracts are trifoliate. The central lobe is composed of a short petiole and a small oval leaf-blade. Sometimes this attempt of the lower axil to produce a flower proves abortive. The already formed petals die away. In such cases the two lateral leaflets die away also, and the little miniature central leaf goes on and developes into one as large as the average on any part of the plant. But in the stronger flowers we find, just in proportion to their strength, the two lateral leaflets enlarge, and the central one diminish until at length it disappears, petiole and all. The laterals then *adhere by their edges*, become fleshy, and end in being petals. These are clearly seen to be formed out of the adnated lateral leaflets, which form the stipular sheaths in other cases, with the central of the trifoliate type absorbed. This observation, in addition to the use I wish to make of it, con-

firms the views of some botanists, as I have learned from Professor Asa Gray, that it is by metamorphosis of the petiolar and stipular parts, rather than by modifications of the leaf-blade, that petals are formed.

From these facts we gather the certainty of a trilobate type of leaf and see the adnation of the edges; and only the dorsal adhesion to the petiole, which I have shown so probable as almost to amount to a certainty, is left to be established by actual fact.

This ternate division of the leaf is a marked character in Ranunculaceæ; and with this exposition of a ternate type in Magnoliaceæ, its claim to a place in the Ranal alliance, strong as it always has been acknowledged to be, is still more strengthened.

It is impossible to suppose that a genus so closely allied as *Liriodendron* should be founded on a different type from *Magnolia*. We shall see that only very slight causes, which we can well understand, have made some of the chief foliar distinctions; and the few which we cannot prove from actual facts can be made almost certainties from parallel observations. The identity of type will in this way be manifest.

First, as to the premorse or cut-off appearance of the end of the leaf-blade. This all results from the stipular portions being adnate with the stem-axis, instead of being wholly on the petiole as in *Magnolia*. In the latter the stipules are carried along as the petiole advances, the leaf-blade cannot grow beyond, and so in vernation has to lie flat up against them. In *Liriodendron*, the stipules being fast to the main stem, the petiole carries the leaf-blade beyond them, over which it is bent until its apex is brought down in contact with the straight line formed by the union of stipule and stem. Here it is pressed as into a mould by the elongating petiole, and the form of the leaf which we see is the necessary result. These processes in *Magnolia* and *Liriodendron* can readily be seen on an examination of the buds at any time during the growing-season; and to those who have no specimens the figure of the latter in Gray's 'Genera' will easily give the idea. It may be here noted that those who look only to Mr. Darwin's principle of natural selection to account for the laws of form, might be troubled by such cases as these. It is scarcely conceivable that a square-edged leaf-blade, as we find it in *Liriodendron*, is of any special benefit to the species; yet if this form is the consequence of some other act which is a benefit, the selection principle may still hold.

If the ternate type of leaf is probable in *Liriodendron*, as in *Magnolia*, the lower portion of the petiole, and lateral or stipular portions, must have adnated with the stem prior to the full development of the leaf. This view necessitates the idea that the leaf does not always originate at the node from which it seems to spring. I do not believe it does; but I am well aware that in this I have opposed to me the weight of our best botanical authorities, from whom I would not yet dare to differ until I shall have the weight of more facts. I would only say that in the case of *Liriodendron* the appearances are much in favour of the belief that in an early stage the petiole clasped the stem, and for a considerable length ultimately

became an integral part of its cortical system. The vessels which are seen connected in direct lines with the petioles below and above the node, as they are in existence before the leaf-bud has opened and the leaf-blade has had any chance to elaborate sap from the light or air, just above supposed to be necessary before they could be formed, do not seem to originate at the node; while the fact that these vessels suddenly curve from the opposite side towards the supposed petiolar base is much more characteristic of an unfolding sheath than of a descending current of matter, which would most naturally go down in a straightish line. But that the petiole has really adnated with the stem in this way in *Liriodendron* seems most probable from the fact that on the opposite side from the leaf is often seen a ridge which could hardly be formed except by the meeting of two edges enclosing a stem, with a little to spare; and at other times there is a slight depression, as if the two opposite edges barely met. There seems to be every evidence short of an actual witnessing of the fact, that the petiole in *Liriodendron* became adnate with the stem, and in this way the two lateral sections (stipules) were brought into contact with the stem with which they united. This would bring them nearer the sources of nutrition, and enable them to assume a more leaf-like and permanent character than if on the petiole. They become rather primary than secondary leaf-organs; and this is just what we see them to be.

Thus we may assume that *Magnolia* has typically a ternate leaf-structure, that the stipules are the two lateral lobes, which, by a peculiar process of adnation, became stipular sheaths after having been partially organized as leaf-blade, and that *Liriodendron* differs from *Magnolia* only in possessing a greater power of adnation.—*Proc. Acad. Nat. Sci. Philad.* Oct. 1870.

A Remarkable Myriopod. By Dr. A. S. Packard, Jun.

While looking over a chip with Myriopods and Poduras on the underside, brought in from the museum grounds by Mr. C. A. Walker, I detected a lively little yellowish-white creature, which immediately suggested Sir John Lubbock's *Pauropus*. A closer examination showed that it was indeed a species of *Pauropus*, very closely allied to *P. pedunculatus*, Lubbock, and intermediate in some respects between that species and *P. Huxleyi*, Lubbock. It may be called *Pauropus Lubbockii*, in honour of the original discoverer of this remarkable type of Myriopods. No more interesting articulate has been discovered for many years; and the occurrence of a species in America is worthy of note. It has but nine pairs of legs (three pairs when hatched), and in some points in its organization seems to be a connecting link between the Myriopods and Poduridæ, the latter being true insects, probably degraded Neuroptera. Our species is yellowish white, and ·03 of an inch in length. Mr. Walker assures me, after seeing this specimen, that he saw a similar one last May under the bark of an apple-tree in Chelsea, Mass.—*American Naturalist*, vol. iv. Dec. 1870.